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ORIGINAL ARTICLE

Analysis of Use of an Automated Bolus Calculator Reduces Fear of Hypoglycemia and Improves Confidence in Dosage Accuracy in Type 1 Diabetes Mellitus Patients Treated with Multiple Daily Insulin Injections

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Abstract

In this issue of *Journal of Diabetes Science and Technology*, Barnard and colleagues evaluate the use of the ACCU-CHEK® Aviva Expert blood glucose meter/bolus advisor system in patients with type 1 diabetes mellitus. Hypoglycemia is a major limiting factor to intensive glucose control, and fear of hypoglycemia, especially in those who have experienced severe reactions, is a major barrier. The bolus advisor improved overall glucose control and increased adherence by overcoming the patients' fear of hypoglycemia, giving them more confidence to give adequate doses of insulin to control hyperglycemia. In this review, we discuss other human factors that become barriers to intensive control, which can benefit from new technologies, including numeracy literacy, information overload, time required for diabetes self-care, and device incompatibility.

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Discussion

Major advances in diabetes technologies are transforming the management of this disease for the patient and their health care providers. These new sophisticated devices enhance diabetes management, but they also create new problems; patients now use multiple, often noncompatible devices (how many devices are they willing to wear and/or carry?), which require additional training to operate and increase time to properly use and communicate with their physician. Finally, they also generate large volumes of glucose, pump, and life-event data, which must be captured and interpreted by health care providers, who then relate informed treatment recommendations back to the patient—all human factors which can be overcome with technology (**Table 1**).

Numeracy Literacy

The ACCU-CHEK® Aviva Expert blood glucose meter and bolus advisor system helps to overcome a major poorly recognized issue for patients with diabetes—numeracy literacy. Defined as the ability of a person to reason with numbers and other mathematical concepts, numeracy literacy applies to reading and understanding

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Abbreviations: (CGM) continuous glucose monitoring, (MDI) multiple daily injections

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food labels for counting calories and carbohydrates, calculation of meal insulin bolus doses or correction doses, and measuring insulin doses. Low literacy and poor numeracy skills are common in patients with diabetes[1] and often result in deficits in understanding nutrition labels, fewer self-management behaviors, worse perceived self-efficacy, and poorer glycemic control.[2,3] With the increasingly complex insulin regimens now being used to treat all forms of diabetes, numeracy illiteracy becomes an even greater problem. Bolus advisors are very effective at improving glucose control, are considered easy, are associated with a high patient satisfaction.[4,5]

Information Overload for the Health Care Provider

Barnard and colleagues found that patients using the bolus advisor increased their self-monitoring of blood glucose frequency.[6] A third of their patients monitored over 6 times a day. We have previously discussed the tremendous volumes of glucose data that can be generated by glucose monitoring. A patient who monitors 6 times a day generates 540 data points in the 3 months between office visits, which a health care provider attempts to interpret at each visit. A patient using continuous glucose monitoring (CGM) generates over 25,000 data points in that same time! Data management software provided by the major pump, glucose sensor, and meter manufacturers can now automatically compile reams of data for health care providers to review, but this software does not automatically and systematically analyze the data or offer therapeutic suggestions. We have lamented that diabetologists are in a paradoxical situation of having both too much data and not enough data at the same time.[5] This contributes to "clinical inertia" in diabetes management even among the most conscientious physicians.[5] To manage this data overload and reduce the burden on the patient and the health care provider, blood glucose and life-event data should be easily collected and then automatically analyzed by some form of intelligent decision support software capable of identifying glycemic control problems and suggesting appropriate changes to therapy. This application could improve the ACCU-CHEK® Aviva Expert blood glucose meter and bolus advisor system.

Time Requirements for Diabetes Self-Care. The components of self-care go far beyond insulin dosing administration. Meal planning, shopping for food, preparing meals, carbohydrate counting, matching carbs to medication, and problem solving when an unexpected result occurs (high or low) require a substantial time and energy commitment. Self-care is overwhelming early in the disease, and it can wear people down over the duration of the disease. Research by the authors demonstrated that it takes more than 3 hours per day to do all of the components of daily self-care for a child on multiple daily injections (MDI) or insulin pump therapy.[7] Any steps in self-care that can be automated can significantly improve care and quality of life. The ACCU-CHEK® Aviva Expert blood glucose meter and bolus advisor system would allow increased efficiency in meal and correction boluses for those who are on MDI. It should be noted that these tools should reduce time demands, but they are optimally used only after the person has developed the skills to bolus manually.

Table 1.
Human Factors of Diabetes Care That Can Be Overcome by Technological Innovation

Fear of hypoglycemia
Numeracy literacy
Data overload
Excessive time requirements
Technology literacy
Device incompatibility

Need for Industry-Wide Compatibility of Devices. One of the major pleas from patients and health care providers at every annual meeting of the American Diabetes Association and the Diabetes Technology Society is that new devices communicate with each other regardless of manufacturer. Most manufacturers attempt to develop proprietary diabetes management solutions and resist development of a common platform. Companies collaborating with other companies often maintain firewalls, which prevent an open system. Protection of intellectual property is a valid concern for all businesses; however, we believe that a uniform device platform for diabetes management devices would enhance creativity and increase business opportunities (look at the explosion in computer development that occurred when the Microsoft DOS® operating system was adopted by most computer manufacturers in the 80's!) without loss of proprietary property or hurting business.

Our Wish. We wish that diabetes medical equipment manufacturers would do as the computer and smart phone industries have done and agree to at least a common communication platform. Imagine smart phone/glucose meter devices, such as sanofi-aventis iBGStar®, using a barcode reader or a photo of food to be eaten at each meal to automatically calculate calories, carbohydrates and a mealtime bolus dose. Imagine CGM/pump/glucose meter data all being transmitted and integrated by the same smart phone (OneTouch®Ping®) by Bluetooth® or infrared.

This data, in turn, could be emailed to a web database (Medtronic CareLink® system) and then interpreted by sophisticated case-based reasoning software systems (4 Diabetes Support System™). Changes in therapy could then be rapidly text messaged or emailed back to the patient as frequently as needed, depending on the stability of their glucose control. If there was a uniform communication platform for these devices, we could at least "close the communication loop" and splice together a very data-driven comprehensive method of managing patients with diabetes. A more open or uniform architecture for all new durable diabetes medical equipment would truly enhance this process, improve diabetes management and patient quality of life, and generate even faster technological innovation.

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